

Report for 2002MS3B: Hydrologic Controls on Wetland Tree Growth: Determining the Origin, Residence Time and Water Quality of Groundwater in the Root Zone

- Conference Proceedings:
 - Galicki, S., G. Davidson, S. Threlkeld and B. Laine, 2002, Role of wetland sedimentation, precipitation, agricultural runoff, and subsurface flow on bald cypress growth. North-Central Section (36th) and Southeastern Section (51st), GSA Annual Conference, GSA Abstracts with Programs, Lexington, KY, April 3-5, 2002, 34:A-106.

Report Follows:

PROBLEMS AND RESEARCH OBJECTIVES:

Preservation of natural wetlands is a national priority, but there is still much to be learned concerning the impact of human activity on wetland systems. In areas of intensive agricultural production, nearby wetlands often serve as collection points for agricultural chemicals and sediments eroded from fields. Construction of roads and drainages alter the hydrologic regime in ways that can enhance or diminish the water supply in the wetland. The response of wetland organisms to these alterations are likely caused by multiple factors, not all of which may even be recognized. The end result is that the response of an organism to changes in wetland dynamics is often *observed* rather than *understood*. Effective management of natural wetlands requires an understanding of how changes in the wetland influence specific organisms.

The bald cypress (*Taxodium distichum*) is a dominant wetland tree species throughout the southeastern United States, and is prolific in the wetlands of Mississippi. The primary control on growth has often been linked to precipitation, but the link is poorly understood. Trees growing in continuously flooded soils still appear to respond to precipitation with higher rates of growth, which means precipitation may often be an indirect cause of growth. The true stimulus may be the flushing of nutrient-rich or oxidizing water through the root zone, or the delivery of nutrients via transported sediments during precipitation runoff events. Proactive management of bald cypress dominated wetlands requires a more thorough understanding of the hydrologic variables that potentially impact this population.

METHODOLOGY:

Funds for the current study were provided in May, 2002. At that time, three sets of nested piezometers were placed in Sky Lake to monitor hydraulic head and water chemistry changes over time. Shortly after placement, unseasonably high water levels in the lake rose above the tops of the piezometers, which compromised future water sampling at these sites. Water levels soon dropped below the tops of the piezometers, but remained unseasonably high through June. As soon as the water level returned to its normal summer low, the piezometers were pulled and moved to new locations. The top of each piezometer was extended to ensure that they will not be submerged again. Data-logging pressure transducers were placed in two piezometers at each nest and set to record water levels every hour. An additional transducer was placed in the lake to record lake level. Continuous monitoring of hydraulic head in the newly placed piezometers began in August. Time was allowed for water levels in the piezometers to equilibrate before sampling for chemical and isotopic analyses beginning in September.

An example of the hydraulic head data is provided in Figure 1. During the Fall, a substantial downward gradient existed at all three nests. The horizontal gradient was more complex. The hydraulic head in the piezometers completed at 1.8 m consistently declined toward the south suggesting flow toward the lake. The deeper piezometers showed a hydraulic high in the middle nest. This apparent anomaly was persistent throughout the period of monitoring. Figure 1 also demonstrates that the hydraulic conductivity of the sediments in the root zone is very low. Water levels do not have time to recover between the water-quality sampling intervals. A second set of 3.8-cm diameter piezometers have now been purchased and are scheduled for installation before the new year. The existing 2.5-cm piezometers will be devoted solely to monitoring hydraulic head. At present, the two deeper piezometers at each site are equipped with data-logging pressure transducers. Three more transducers have now been ordered for the shallow piezometers at each nest.

Oxygen isotope data are now available for two sampling rounds. This is not yet enough data to make assessments of residence time, but several processes are already clear from the limited data set. First, substantial evaporation from the lake is evident from the elevated summer $\delta^{18}\text{O}$ values for lake water (+3‰ VSMOW) relative to stream inflow values (-1.3 to -4.9‰). Second, the influence of Hurricane Lili (Sept. 21, 2002) was apparent from a significant drop in the precipitation $\delta^{18}\text{O}$ value. Normal values during this time of year have been in the range of -3 to -6‰. Hurricane Lili delivered water with a $\delta^{18}\text{O}$ of -11‰. Lastly, the $\delta^{18}\text{O}$ of groundwater in the root zone is more similar to inflowing stream water than to the enriched summer lake-water, which is consistent with the hydraulic gradient observed in the 1.8 m piezometers. Changes will be monitored with time to determine if the isotopic signature approaches lake values during the winter months when the lake level is high.

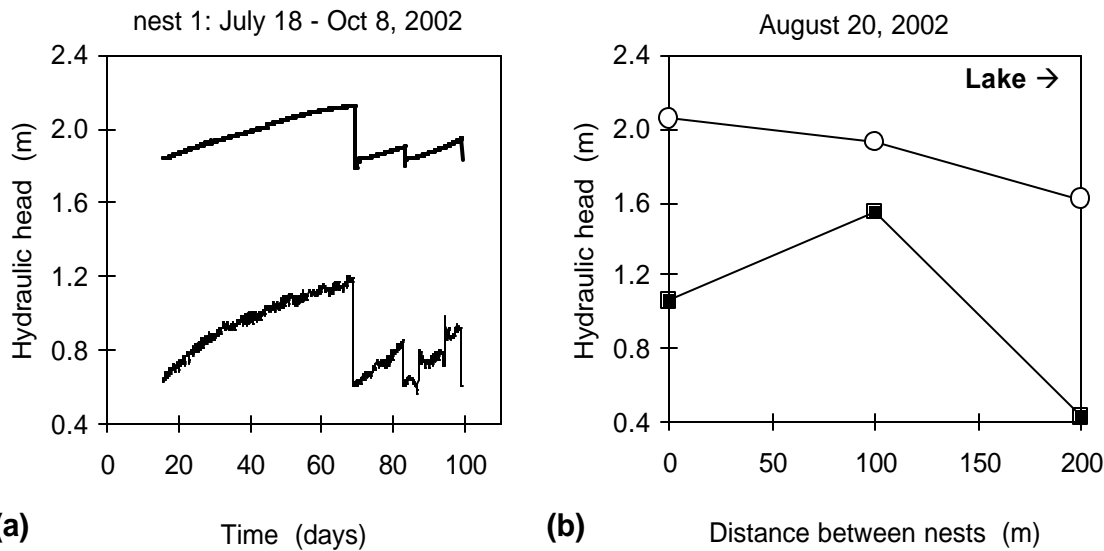


Figure 1. (a) Continuous hydraulic head measurement in piezometer nest 1 (highest elevation). Upper curve is for 1.8 m depth, lower curve is for 3.0 m depth. Sudden drops represent water removal for water-quality sampling. (b) Hydraulic head in the 1.8 m piezometers (open circles) and 3.0 m piezometers (filled squares) in all three nests on August 20, 2002.

SIGNIFICANCE:

Completion of this project will yield two end products. First, the results will enhance our understanding of the hydrologic controls on the health of a dominant wetland tree species: the bald cypress. This will in turn lead to an improved ability to manage the natural wetlands of the southeastern United States, particularly regarding issues of sediment accumulation and alterations to the hydrologic regime. Specific information gained from the project for a specific wetland will include characterization of nutrient availability associated with precipitation events, identification of the origin of shallow subsurface water, and quantification of shallow groundwater residence time at variable depths.

The second product will be a general characterization of wetland hydrology for a type of wetland in a geographical area that is under-represented in the published literature. The study site is in the Delta region of Mississippi, characterized by low relief and many oxbow-lake wetlands. These wetlands are unique in that they often lie near streams or other lakes that can fill quickly during high stream flows, sometimes reversing shallow groundwater gradients.